Form 2.0L Landfill Worksheet

Facility Name		FIPS County No.	Plant No.	Year of Data

Point No.	Segment Number	Source Classification Code (SCC)

LANDFILL INFORMATION

Type of Landfill		
☐ New	**If closed, date of last waste accepted:**	☐ **Used EPA's Software (Landgem) (Attach summary.)**
☐ Existing		
☐ Closed	Time since closure (yrs): c = *Cell B13*	
Type of Control		☐ **Used MDNR's MSExcel Spreadsheet (Attach copies.)**
☐ Flare	Age of landfill (yrs): t = *Cell B11*	
☐ Control System		
☐ Enclosed Combustor		
☐ None	Capture Efficiency (%) :	*Default is 75%. Documentation must be supplied for other values.*

Destruction Efficiency (%) :	Landfill Design Capacity : (cubic meters)
Avg. Annual Refuse Acceptance Rate (Mg/yr) : R= *Cell B12*	Mass of solid waste in the Landfill (Mg) :
Acres of Landfill : *Cell B14*	Gas sent off-site (mmcf) : *Cell B16*

CALCULATION OF EMISSIONS

Default values are 100 m^3/Mg for L (Methane Generation Rate Potential), and 0.04 /yr for k (Methane generation rate constant)

Methane Generation Rate (QCH4) : (m3/yr) *Cell J5*	Methane Generation Rate : (mmcf) *Cell K5*
SO2 Emissions (lb/yr) : *Cell O16*	HCl Emissions (lb/yr) : *Cell O17*
NMOC (VOC) Fugitive Emissions (lb/yr) : *Cell G85*	NMOC (HAP only) Fugitive Emissions (lb/yr) : *Cell G48*
NMOC (VOC) Collected, Uncontrolled (lb/yr) : *Cell I85*	NMOC (HAP only) Collected Uncontrolled (lb/yr) : *Cell I48*
NMOC (VOC) Emissions from Control (lb/yr) : *Cell K85*	NMOC (HAP only) Emissions from Control (lb/yr) : *Cell K48*

CALCULATION OF EMISSION FACTORS

Report fugitive emissions and controlled emissions on separate Forms 2.0. Fugitive emissions use SCC 50100402, and throughput units of acres.

VOC Fugitive Emission Factor : (lb/acre) *Cell J32*	HAP Fugitive Emission Factor : (lb/acre) *Cell J33*

Waste gas flares use SCC 50100410, throughput unit of MMCF burned. For SCCs for other controls, please contact your regulatory agency.

VOC to Control Emission Factor : (lb/mmcf) *Cell L32*	HAP to Control Emission Factor : (lb/mmcf) *Cell L33*

MO new number (09/02)

INSTRUCTIONS
FORM 2.0L LANDFILL INFORMATION

This form should be used if a facility is a landfill or has a landfill on the premises.

Use one Form 2.0 Emission Point Information for the fugitive emissions, and another Form 2.0 Emission Point Information for emissions from the control device. The SCC for the fugitive emissions should be 50100402, and the emission factor units are <u>lb./acre.</u> The SCC for emissions from a flare is 50100410, and the emission factor units are <u>lb./mmcf.</u> Please call your regulatory agency for SCCs and emission factor units for other types of control devices.

Complete **<u>Facility Name</u>, <u>County Number</u>, <u>Plant Number</u>** and **<u>Year of Data</u>**.
See Form 1.0 instructions, Page 1.0-1.

The **<u>Point Number</u>, <u>SCC</u>** and **<u>Segment Number</u>**, will be the same as those indicated on the Form 2.0 that must accompany this form.

The cell numbers shown on the form refer to the MDNR MS Excel spreadsheet you may use to calculate landfill emissions. The spreadsheet calculates both fugitive and controlled emissions of individual pollutants, totals, and emission factors. It will also provide a printable version of Form 2.T Hazardous Air Pollutant Worksheet.

<u>Section 1: Landfill Information</u>

<u>Type of Landfill</u> - put an "X" in the block that most accurately describes the landfill.

> **New** - a new Municipal Solid Waste (MSW) landfill is a landfill for which construction, modification, or reconstruction commences on or after the date of May 30, 1991 or that began accepting waste on or after that date.
>
> **Existing** - an existing MSW landfill is a landfill for which construction, reconstruction or modification was commenced before May 30, 1991, and has accepted waste anytime since November 8, 1987, or has additional design capacity available for future waste deposition. An existing MSW landfill may be active (currently accepting waste, or have additional capacity available to accept waste) or may be closed (no longer accepting waste nor having available capacity for future waste deposition). Closed landfills that have accepted waste after November 8, 1987 are considered existing landfills.
>
> **Closed** - landfill has gone through closure with the Department of Natural Resources Solid Waste Management Program or the EPA.

<u>If closed, the date of last waste accepted</u>. If the landfill is not currently accepting waste, put the date of the last waste acceptance.

Time since Landfill Closure - c - (yr.) - The amount of time since closure of the landfill in years. For active landfills c = 0. This should be calculated in the same manner as the age of the landfill.

Age of the Landfill –t- (yrs) - time since the initial refuse placement in years.

> Example: If the landfill opened in March of 1992 and started accepting waste in June of 1992 and is currently still accepting waste, the age of the landfill for the 1996 emission year would be:

> December 1996 - June 1992 = 4 years and 7 months = 4 +(7/12) = 4.583 years

Used EPA's Software (Landgem) or Used MDNR MS Excel Spreadsheet Put an "X" in the appropriate box and attach a summary of the Landgem report or a copy of the spreadsheet.

Type of Control - put an "X" in the block that most accurately describes the control equipment present at the landfill. According to the NSPS standard the state plan has three options for the control of collected MSW landfill emissions by using control devices:

Flare	- an open flare designed and operated in accordance with the parameters established in 40 CFR Part 60.18; or
Control System	- a control system designed and operated to reduce NMOC by 98 weight percent; or
Enclosed Combustor	-an enclosed combustor designed and operated to reduce the outlet NMOC concentration to 20 parts per million as hexane by volume, dry basis at 3 percent oxygen, or less.

Capture Efficiency: The capture efficiency for the landfill gas collection system. The default is 75%. Documentation must be supplied if a higher percentage of collection is used.

Destruction Efficiency: The destruction efficiency for the control indicated.

Landfill Design Capacity - The maximum amount of waste (volume) that the landfill will be able to accept in cubic meters (m^3).

> If the maximum amount of waste is known in cubic yards, the following equation can convert it to cubic meters:

$$cubic\,meters = (cubic\,yards)\left(0.76458\,\frac{m^3}{yds^3}\right)$$

Average Annual Refuse Acceptance Rate - R - (Mg/yr) - Site-specific landfill information is generally available for the average refuse acceptance rate. When refuse acceptance rate information is scant or unknown, R can be determined by dividing the refuse in place by the amount of time that the landfill was accepting waste. Nondegradable refuse should be subtracted from the mass of the acceptance rate to prevent overestimation of methane generation. The average annual acceptance rate should only be estimated by the above method when there is inadequate information available on the actual average acceptance rate.

>   If the amount of waste is known in tons, the following equation can convert it to
>   Megagrams:

$$Megagrams = (Tons)\left(0.90718\frac{Mg}{Tons}\right)$$

Mass of solid waste in the landfill (Mg) - the amount of degradable solid waste that has been accepted into the landfill. The mass of nondegradable solid waste should be subtracted from the total mass of solid waste accepted into the landfill to calculate this value. For the emission year, this would be the mass of solid waste accepted into the landfill from the initial refuse placement until December 31 of the reporting year.

>   **Nondegradable waste** is any waste that does not decompose through chemical
>   breakdown or microbiological activity. Examples are, but are not limited to, concrete,
>   municipal waste combustor ash, and metals.

Acres of Landfill: Estimate the acres of land currently in the landfill.

Gas sent offsite (mmcf): If any landfill gas is sent offsite for use at another facility, record the amount sent. This number will be subtracted from the amount of landfill gas sent to the control device.

Section 2:Calculation of Emissions

Methane Generation Rate - QCH4 - (m^3/yr) - this value can be calculated by the following equation:

March 12, 2004

Instructions for Form 2.0L
Landfill Information
Continued

$$QCH4 = LR\left(e^{-kc} - e^{-kt}\right)$$

Where:

QCH4	= Methane generation rate m^3/yr
L	= Methane generation potential m^3 CH_4/Mg refuse
R	= Average annual refuse acceptance rate during active life, Mg/yr
e	= Base log, unitless
k	= Methane generation rate constant, /yr
c	= Time since landfill closure
t	= Time since the initial refuse placement

The values for k and L are 0.04 /yr and 125 m^3/Mg, respectively.

Methane Generation Rate (mmcf): Multiply the methane generation rate in m^3/yr by 0.0000352 mmcf/m^3 to convert to mmcf/yr.

SO$_2$ Emissions: SO_2 is a combustion product from landfill gas controls. Use the following equation to calculate SO_2 emissions:

$$1.82(QCH4)\left(\frac{46.9\,ppmv}{1000000}\right)\left(\frac{32}{(0.00008205)(1000)(298)}\right)\left(\frac{CollectionEffncy}{100}\right)(2)\left(\frac{2.2046lb.}{kg}\right) = UmS$$

Where:

UmS	= Controlled mass emissions of SO_2, lb./year.
46.9 ppmv	= default concentration of total reduced sulfur compounds
32	= molecular weight of sulfur
2	= Ratio of the molecular weight of SO_2 to the molecular weight of S.

If any landfill gas is collected and sent offsite, those emissions should be subtracted from this amount.

HCL Emissions: HCl is also a combustion product for landfill gas controls. Use the following equation to calculate HCl emissions:

$$1.82(QCH4)\left(\frac{42.0\,ppmv}{1000000}\right)\left(\frac{35}{24.4509}\right)\left(\frac{CollectionEffncy}{100}\right)(1.03)\left(\frac{ControlEff}{100}\right)\left(\frac{2.2046lb.}{kg}\right) = UmHCl$$

Instructions for Form 2.0L
Landfill Information
Continued

Where:

UmHCl	= Controlled mass emissions of HCl, lb/year
42.0 ppmv	= default concentration of total chloride
35	= molecular weight of chloride
24.4509	= (0.00008205)(1000)(298)
1.03	= Ratio of the molecular weight of HCl to the molecular weight of Cl⁻

If any landfill gas is collected and sent offsite, those emissions should be subtracted from this amount.

The next step is to calculate emissions for individual pollutants, fugitive and controlled, and add them together according to category (HAPs only, HAPs and VOCs, VOCs only). To use AP-42 default values, continue with the instructions on this page.

The Landfill Emissions Spreadsheet attached to these instructions lists the molecular weight, default concentration (ppmv), and INMOC factor for the pollutants required to be reported. The CAS# is also listed for those pollutants required to be reported on the Form 2T Hazardous Air Pollutant Worksheet.

The individual pollutant mass emissions must be calculated for each of the HAPs in Part A and Part B. The HAPs that are VOCs must be reported as VOCs and not as HAPs on Form 2.0. Form 2.T must be completed with the mass emissions of each HAP listed in Part A and Part B. The chemicals that are only VOCs appear in Part C. (Note: the individual mass emissions of the chemicals in Part C do not have to be listed on any form) When all of these values are calculated, the uncontrolled emissions as HAPs can be obtained from the Form 2.T. The uncontrolled emissions as VOCs can be obtained by adding the VOC emissions from 2.T and those calculated from the chemicals on Part C.

The mass emissions of each pollutant on the spreadsheet can be calculated using the following equation (AP-42 Equation (3)):

$$I_{NMOC} = (1.82)(QCH_4)(\text{Default Concentration})(I_{NMOC} \text{ Factor}) \div (1 \times 10^6)$$

Where:

I_{NMOC}	= Individual mass emissions for a specific chemical (lb./yr.)
QCH_4	= Methane Generation Rate m³/yr
Default Concentration	= The value in ppmv for a specific chemical
I_{NMOC} Factor	= Values for specific chemicals

Instructions for Form 2.0L
Landfill Information
Continued

Example: If QCH_4 = 3,000,000 m³/year, the emissions for 111 Trichloroethane would be
$(1.82)(3,000,000 \text{ m}^3/\text{year})(0.48 \text{ ppmv})(12.02 \text{ lb/m}^3) \div (1 \times 10^6)$ = 31.5 lb/yr.

NMOC (VOC) Fugitive Emissions: The total emission of the pollutants listed in Part B and
Part C of the Landfill Emissions Spreadsheet, multiplied by the percentage of landfill gas <u>not</u>
collected. For example, if the total emissions for Part B is 12,000 pounds, the total for Part C is
2000 pounds, and the collection efficiency is 75%, the NMOC (VOC) for fugitive emissions is:
(12,000 + 2000)(0.25) = 3500 pounds.

NMOC (HAP only) Fugitive Emissions: The total emission of the pollutants listed in Part A of
the Landfill Emissions Spreadsheet multiplied by the percentage of landfill gas <u>not</u> collected.
For example, if the total emissions for Part A is 1000 pounds, and the collection efficiency is
75%, the NMOC (HAP only) for fugitive emissions is: (1000)(0.25) = 250 pounds.

NMOC (VOC) Collected, Uncontrolled: The total emission of the pollutants listed in Part B
and Part C of the Landfill Emissions Spreadsheet, multiplied by the percentage of landfill gas
<u>collected</u>. For example, if the total emissions for Part B is 12,000 pounds, the total for Part C is
2000 pounds, and the collection efficiency is 75%, the NMOC (VOC) for collected, uncontrolled
emissions is: (12,000 + 2000)(0.75) = 10500 pounds. If any landfill gas is collected and sent
offsite, those emissions should be subtracted from this amount.

NMOC (HAP only) Collected, Uncontrolled: The total emission of the pollutants listed in Part
A of the Landfill Emissions Spreadsheet, multiplied by the percentage of landfill gas <u>collected</u>. If
any landfill gas is collected and sent offsite, those emissions should be subtracted from this
amount.

NMOC (VOC) Emissions from Control: The total emission of the pollutants listed in Part B
and Part C of the Landfill Emissions Spreadsheet, multiplied by the percentage of landfill gas
<u>collected</u>, and multiplied by the percentage <u>not</u> controlled. For example, if the total emissions
for Part B is 12,000 pounds, the total for Part C is 2000 pounds, the collection efficiency is 75%,
and the control efficiency is 98%, the NMOC (VOC) Emissions from control is: (12000 + 2000)
(0.75)(.02) = 210 pounds. Again, if any landfill gas is collected and sent offsite, those emissions
should be subtracted from this amount.

NMOC (HAP only) Emissions from Control: The total emission of the pollutants listed in Part
A of the Landfill Emissions Spreadsheet, multiplied by the percentage of landfill gas <u>collected</u>,
and multiplied by the percentage <u>not</u> controlled, plus the HCl emissions calculated above. Again,
if any landfill gas is collected and sent offsite, those emissions should be subtracted from this

March 12, 2004

Instructions for Form 2.0L
Landfill Information
Continued

amount.

Section 3:Calculation of Emission Factors

VOC Fugitive Emission Factor: The NMOC (VOC) Fugitive Emissions (pounds) divided by the Acres of Landfill.

HAP Fugitive Emission Factor: The NMOC (HAP only) Fugitive Emissions (pounds) divided by the Acres of Landfill.

VOC to Control Emission Factor: The NMOC (VOC) Collected, Uncontrolled (pounds) divided by the Methane Generation Rate (mmcf).

HAP to Control Emission Factor: The NMOC (HAP only) Collected, Uncontrolled (pounds) divided by the Methane Generation Rate (mmcf),

To use site specific information:

If a site-specific total pollutant concentration is available (as measured by EPA Reference Method 25C), it must be corrected for air infiltration into the collected landfill gas before it can be combined with the estimated landfill gas emissions to estimate total NMOC emissions. The pollutant concentration is adjusted for air infiltration by assuming that CO_2 and CH_4 are the primary (100 percent) constituents of landfill gas, by the following equation:

$$\frac{C_P(ppmv)(1 \times 10^6)}{C_{CO_2}(ppmv) + C_{CH_4}(ppmv)} = C_P \, ppmv \text{ (corrected for air infiltration)}$$

Where:

C_P	= Concentration of pollutant P in landfill gas
C_{CO2}	= CO2 concentration in landfill gas, ppmv
C_{CH4}	= CH4 concentration in landfill gas, ppmv
1×10^6	= Constant used to correct NMOC concentration to units of ppmv

Values for C_{CO2} and C_{CH4} can usually be found in the source test report for the particular landfill along with the total NMOC concentration data.

March 12, 2004

Instructions for Form 2.0L
Landfill Information
Continued

To estimate the emissions of a particular pollutant, the following equation should be used:

$$QP = \frac{1.82\,QCH4\,(CP)}{(1x\,10^6)}$$

Where:

QP	= Emission rate of a particular pollutant, m3/yr
QCH4	= CH_4 generation rate, m^3/yr
CP	= Concentration of P in landfill gas, ppmv
1.82	= Multiplication factor

The following equation can estimate the mass emissions per year of each pollutant:

$$UM_P = Q_P \left[\frac{(MW_P)(1atm)}{(0.00008205m^3 - atm\,/\,gmol -^o K)(1000g\,/\,kg)(273+T\,^oK)} \right] \left(\frac{2.2046lbs}{1kg} \right)$$

Where:

UM_P	= Uncontrolled mass emissions of pollutant P (lbs/yr)
Q	= NMOC emission rate of P (m^3/yr)
MW_P	= Molecular weight of P, g/gmol
T	= Temperature of landfill gas (°C)
2.2046	= Conversion factor from kilograms to pounds

This equation assumes that the operating pressure of the system is approximately 1 atmosphere. . If the temperature of the landfill gas is not known, a temperature of 25°C is recommended.

The individual pollutant mass emissions must be calculated for each of the HAPs in Part A and Part B. The HAPs that are VOCs must be reported as VOCs and not as HAPs on Form 2.0. Form 2.T must be completed with the mass emissions of each HAP listed in Part A and Part B. The chemicals that are only VOCs appear in Part C. (Note: the individual mass emissions of the chemicals in Part C do not have to be listed on any form) When all of these values are calculated, the uncontrolled emissions as HAPs can be obtained from the Form 2.T. The uncontrolled emissions as VOCs can be obtained by adding the VOC emissions from 2.T and those calculated from the chemicals on Part C.

Instructions for Form 2.0L
Landfill Information
Continued

After calculating the mass emissions of each pollutant listed on the Landfill Emissions
Spreadsheet (attached) return to **NMOC (VOC) Fugitive Emissions** page 2.0L-5